



ASTP RBCC Activities

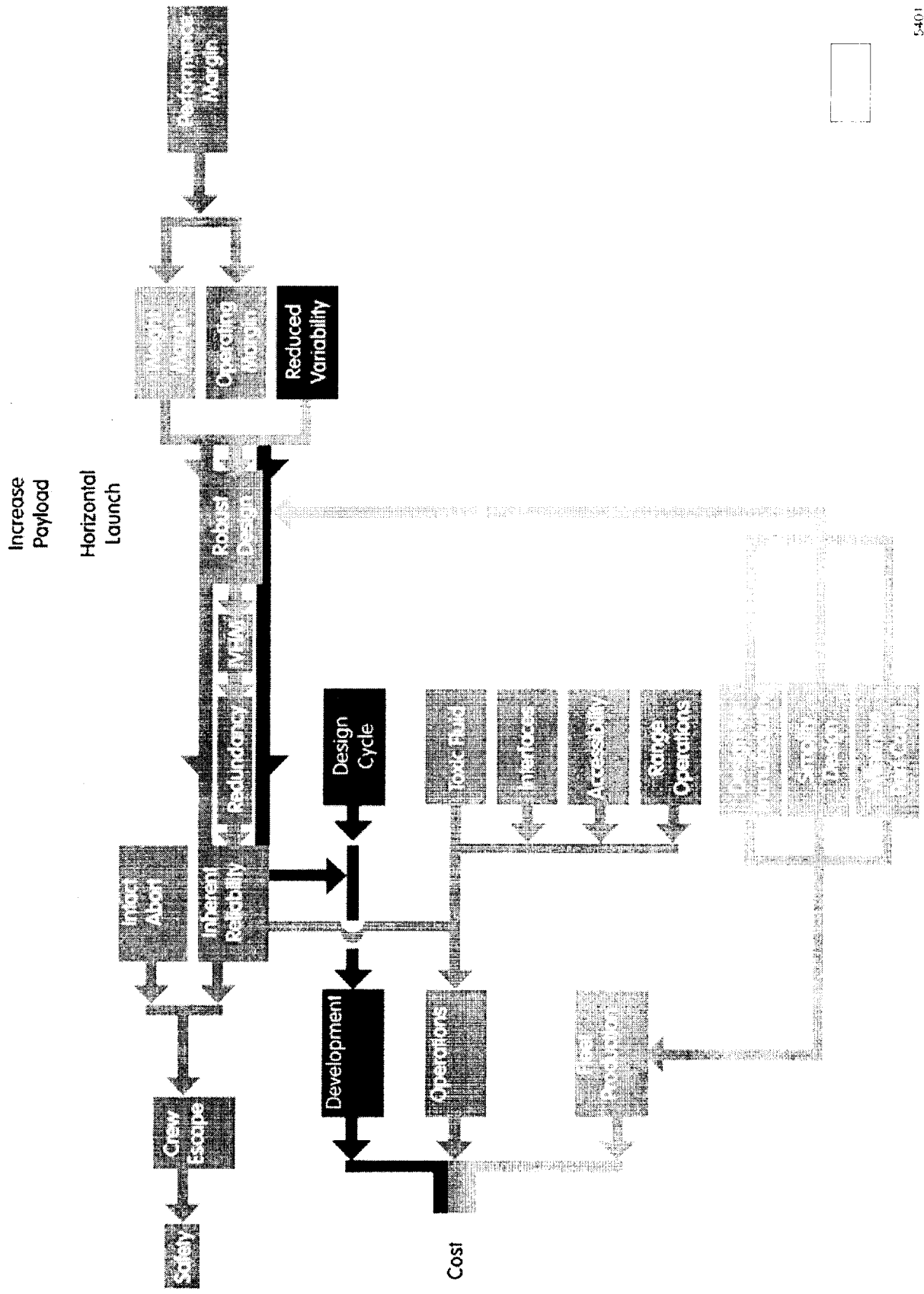
**Karl W. Nelson
Marshall Space Flight Center
10/11/00**



3rd Generation Technology Prioritization Process

- ◆ **Inter-center 3rd Generation team ranked over 70 technologies for**
 - Potential payoff to cost and safety
 - Technological risk
- ◆ **Ranking process included study of technology activity, open discussion and consensus**
 - Analytical Hierarchy Process (AHP) used in final ranking
- ◆ **Technologies prioritized by**
 - A combined score of potential system payoff and technological risk
Technology score = (cost + safety)* risk°
- ◆ **Technologies coordinated with Aero-Space base activities**
- ◆ **Efforts underway to make this annual process**

Pathway to Safety and Affordability

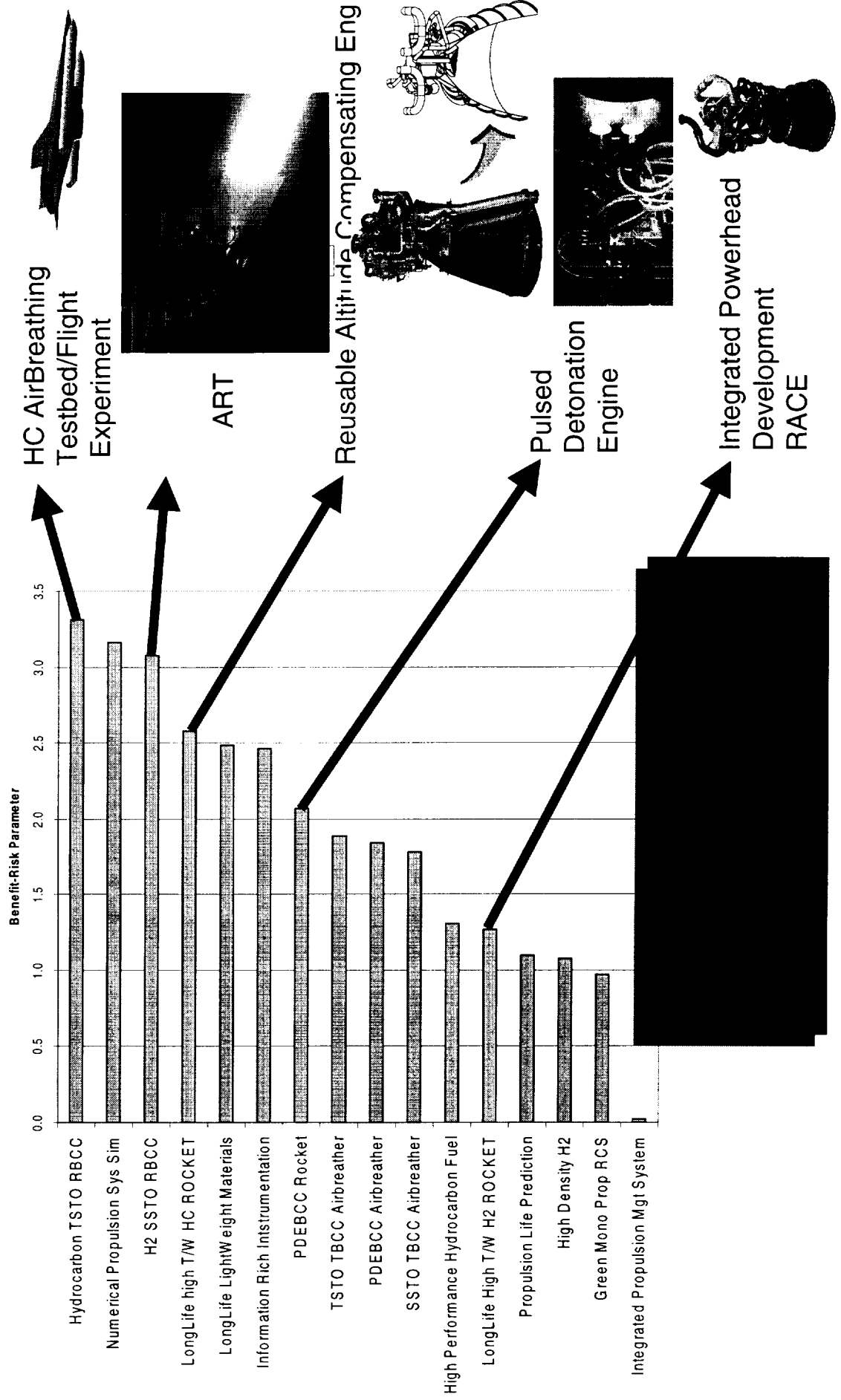




Example 3rd Gen. Propulsion Candidate Investments

Spaceliner Requirements

Building Block Projects





Hydrogen RBCC



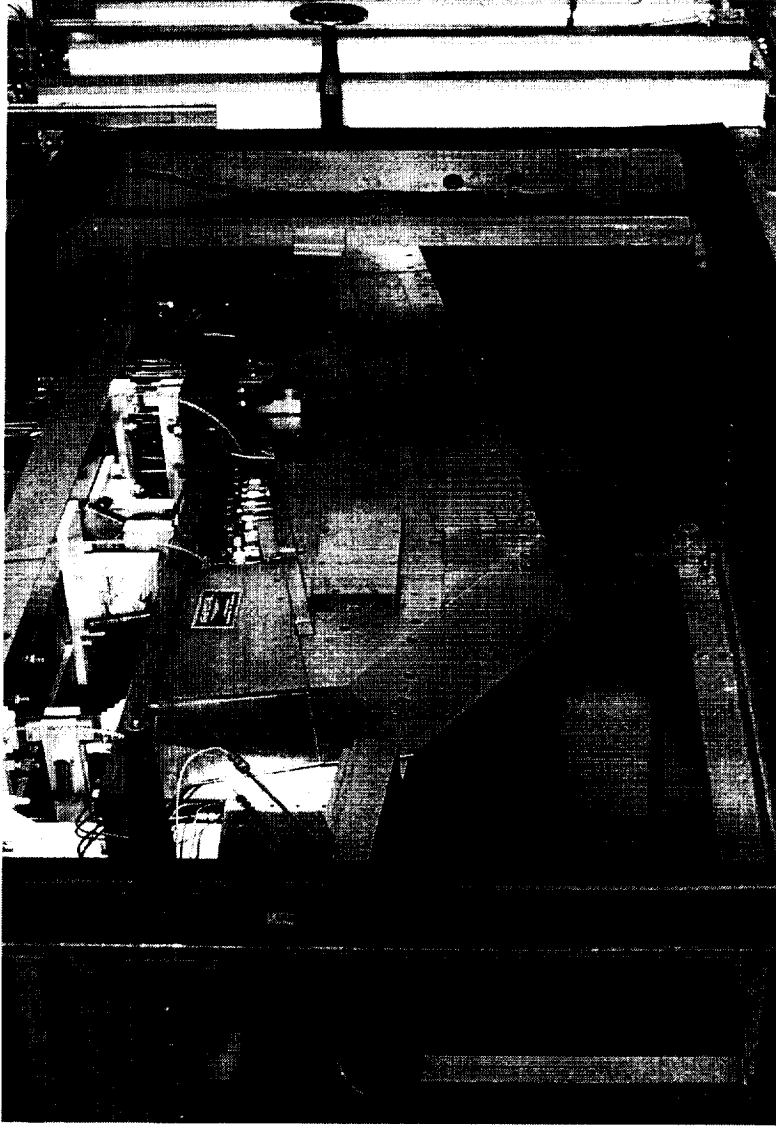
Recent Accomplishments

- ◆ **ART (Advanced Reusable Technologies)**
 - Aerojet & Rocketdyne Flowpath Tested
 - Test Conducted From M 0 to Mach 8
 - Total Of 253 Test Conducted
 - Good Overall Performance
 - Several Firsts In Testing
 - Dynamic Trajectory Simulation (AAR -> RAM and RAM-> SCRAM))
 - SCRAM Testing @ High Dynamic Pressure (M8 @ 1,200 Psf)
 - Rocketdyne A-5 engine has logged over 1 hour of accumulated test time
 - Parametric Test Performed By Pennsylvania State University
- ◆ **Trailblazer Concept Development**
 - Lead By Glenn Research Center
 - Currently Testing @ GASL
- ◆ **System Studies**
 - Various Vehicle/Engine Combinations Being Studied
 - RBCC
 - TBCC
 - PDE
 - Sensitivity Trades Being Made
 - Trajectories
 - Fineness ratio
 - Payload capability

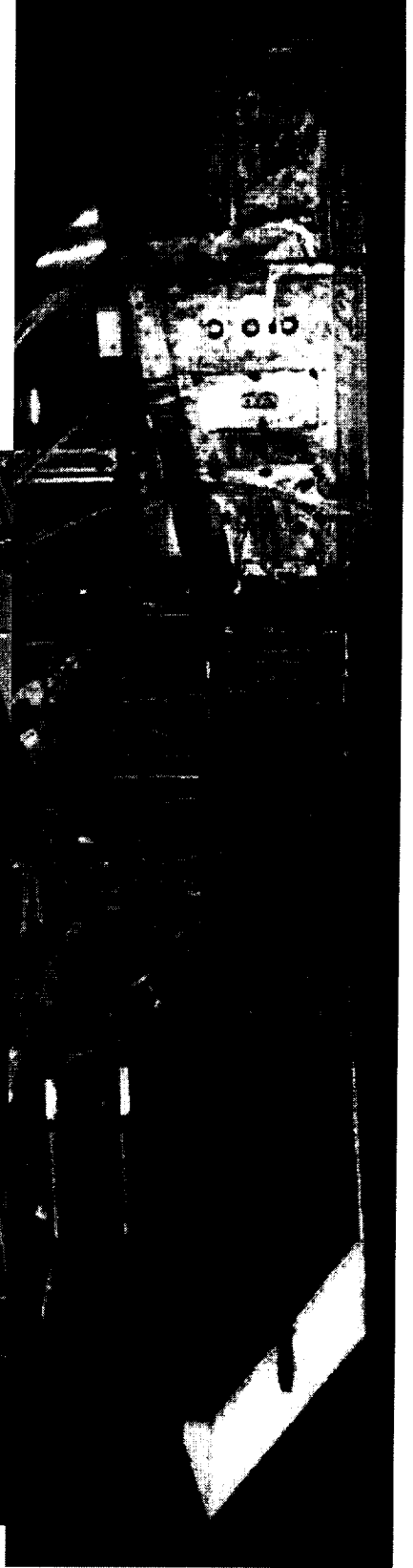


RBCC Focused Concept Flowpaths

Aerojet Flowpath



Rocketdyne Flowpath





Accomplishments (cont'd)

Sea-Level Static	31	173	34	342
Air-Augmented Rocket	12	97	15	288
AAR/RAM Transition	12	97	32	465
- AAR/RAM Traj Sim.	0	0	11	140
RAM	28 (14*)	342 (246*)	21	325
RAM/SCRAM Transition	0	0	2	50
SCRAM	8*	112*	58	1218
SCRAM/Rocket Transition	21*	279*	0	0
Rocket-Only	16	129	10	72

* Direct-Connect Tests



ART Future Plans

- ◆ **Fabricate flight weight components**
 - Rocketdyne combustor
 - Aerojet combustor
 - Aerojet ceramic ram/scram injectors
- ◆ **Test selected components**
- ◆ **Document ART project**

ART is scheduled to conclude in 2001



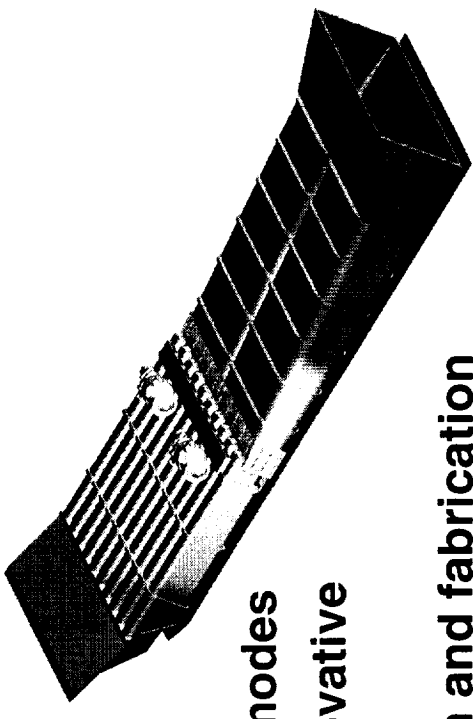
RAPTOR

(Revolutionary Airbreathing Propulsion
Technology demonstratOR)



Combined Cycle Propulsion Testbed

- ◆ Take the next logical step in combined cycle propulsion development
- ◆ Develop a flight-weight rocket based combined cycle engine *system* ground testbed
 - Sized capable of accelerating a self powered vehicle from Mach 0.8 to Mach 7
- ◆ Demonstrate RBCC engine system operation for air-augmented rocket, ramjet, and scramjet modes
- ◆ Provide testbed for evaluation of candidate innovative components
- ◆ Demonstrate flight weight engine system design and fabrication
- ◆ Evaluate engine system operational characteristics
- ◆ In test in 2004
- ◆ A testbed, not a prototype of an operational engine
- ◆ One of several airbreathing engine system testbeds leading to operational engine development(s) beginning in the 2010 - 2015 timeframe





Hydrocarbon Demonstrator Traceability

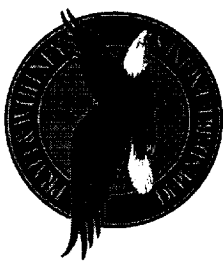
- ◆ **The Hydrocarbon RBCC Engine Systems Demonstrator Provides Traceability to an Operational Launch Vehicle by ...**
 - Developing a flight like, thermal & power balanced RBCC engine system
 - Demonstrating the operation of an RBCC engine system by testing from Mach 0 through Mach 7 in ground test
 - Performing vehicle design and propulsion system integration studies to show the applicability of RBCC to earth-to-orbit propulsion systems



On-Going Activities

◆ Industry Team is Key to Development - HYPAR

- Preserve U.S. high speed propulsion industrial base
- Rocketdyne - Management Lead
- Pratt & Whitney - Technical Lead
- Aerojet - Systems Integration Lead
- MOA signed
- FTC concurrence 8/4
- Teaming agreement to be signed by 10/15
- Program planning underway
- Engine System Study final report week of 10/30



◆ Flowpath Selection Team

- Team has been convening since June
 - Two representatives from each of the engine companies
 - One representative from Boeing Phantom Works
 - One representative from each participating NASA center (DFRC, GRC, LaRC, MSFC)
- Data sharing initiated 7/24
- Selection made 9/1 - Aerojet Strutjet Flowpath



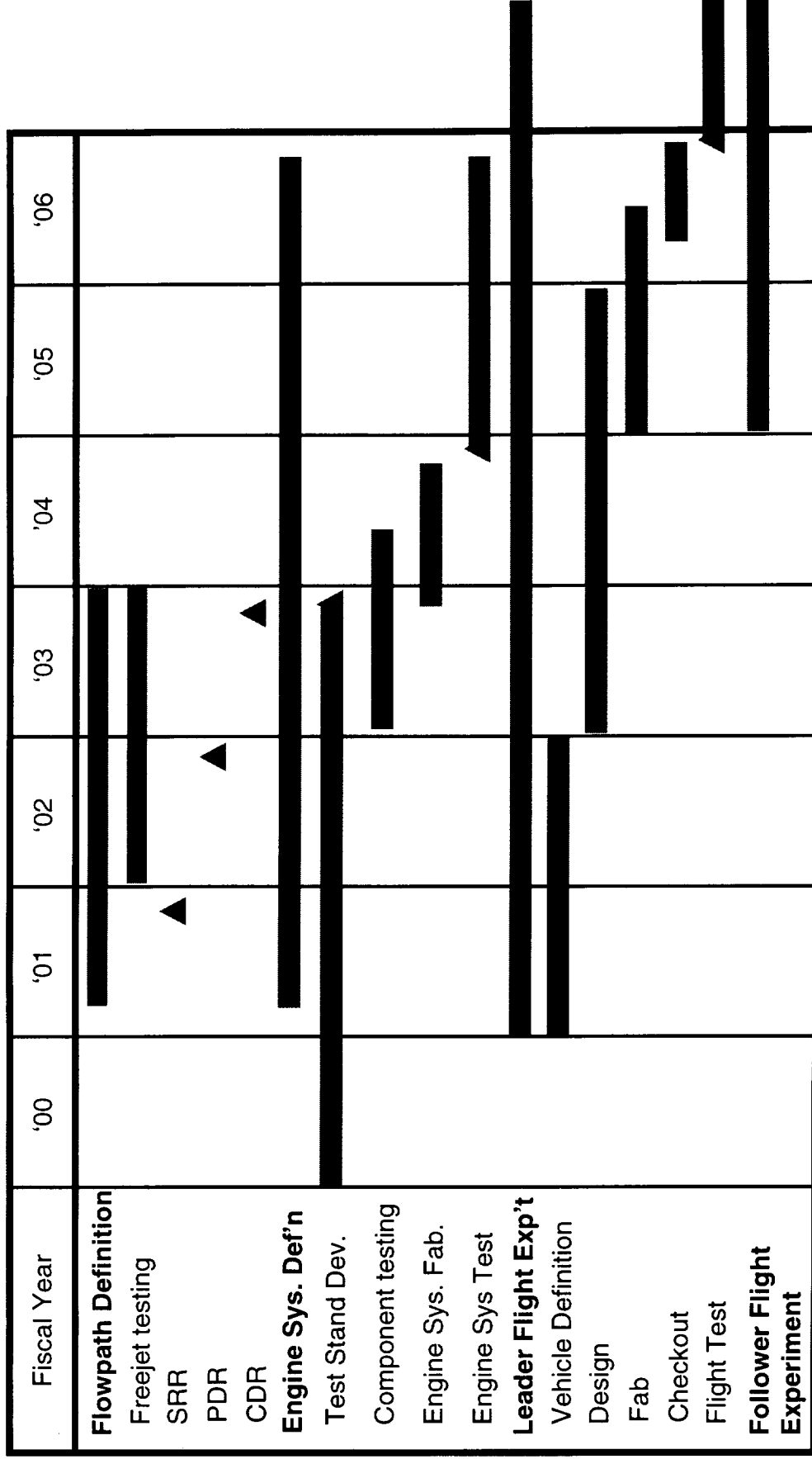


'01 Plans

- ◆ **Perform planning activity 11/00 - 4/01**
- ◆ **Put HYPAR consortium under contract**
- ◆ **Demonstrator vehicle activity led by LaRC**
 - **Feed requirements for engine system**



Long Term RAPTOR Schedule



◆ Flight experiments not part of the RAPTOR project



Milestone/Activities

◆ Milestones

- 10/00 - Engine system study final report
- 9/01 - System Requirements Review (SRR)

◆ Prioritized List of Activities

- Perform detailed project planning
- Implement system engineering framework
- Refine selected flowpath, engine systems concept, and structural approach
- Iterate propulsion/airframe integration